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Abstract

THE SOLVENT EXTRACTION OF THORIUM FROM SULPHURIC ACID
SOLUTIONS BY AMINES

M.A. Awwal

Pakistan Atomic Energy Commission

Amines offer certain advantages as solvents compared with alkyl phosphates in processing irradiated fuels due to the radiation susceptibility of the latter. While extensive studies have been made of the potential of amines in uranium ore processing in sulphuric acid media, less work has been done on the possibility of employing amines as extractants in irradiated fuel reprocessing especially in the Th-U²³³ cycle. Basic chemical studies associated with this possible processing system are reported.

Primary, secondary and tertiary amines have been investigated. Use of primary amines was found to be impracticable whereas secondary or tertiary amines are promising.

Two secondary amines, di-n-octylamine and di (tridecyl) amine as well as two tertiary amines, tri-n-octylamine and methyl-n-didecylamine, were studied in detail. Both the secondary and tertiary amines have shown suitable extraction properties for both uranium and thorium from sulphate media especially in the range 10^{-2} to 10^{-1} NH_2SO_4 . The secondary amines show a preferential extraction of thorium while the tertiary amines preferentially extract uranium. The secondary amine sulphates at a concentration of 0.1 M have a partition coefficient for the extraction of thorium which decreases from a value in excess of 10^3 for acid concentrations of 10^{-2} NH_2SO_4 to approximately unity at aqueous acid concentrations of 0.5N. Under similar conditions uranium gives similar results but reduced in magnitude by a factor of four. With 0.1 M tertiary amines the partition coefficient for the extraction of thorium decreases from a value of approximately 5 at 10^{-2} NH_2SO_4 , to a value of approximately 0.5 at 0.5 NH_2SO_4 . Under the same conditions uranium gives a partition coefficient V's acid concentration

curve of similar shape but with partition coefficients increased by a factor of 10^2 .

Thus while the secondary amines provide the higher partition coefficients for the extraction of uranium and thorium, the tertiary amines provide the greatest difference between the values for the extraction of uranium and thorium under similar conditions. Because of this although the secondary amines would appear attractive to extract both the uranium and thorium from a feed solution the tertiary amine solvents offer better subsequent thorium and uranium separation by selective stripping of the solvent.

In partition coefficient V's amine sulphate concentration studies a greater dependence and hence flexibility in the selection of extraction conditions was found for the tertiary amines. These results also pointed to at least two different extracting species although paper electrophoresis experiments which clearly showed the presence of anionic species failed to confirm the existence of multiple species.

Thorium loading studies show a far greater falling off in extraction with secondary amines for thorium concentrations above 0.01 M than is the case with tertiary amines so that whereas secondary amine partition coefficients are 100 times higher than tertiary amine coefficients at thorium concentrations of 0.005 M they are of almost equal value at thorium concentrations of 0.05 M.

The greater differences in the partition coefficients for thorium and uranium with tertiary amines together with the greater dependence on amine concentration and similar overall partition coefficients at the higher thorium concentrations indicates that the tertiary amines provide the better basis for a uranium and thorium isolation and separation system in spite of the apparently greater attraction of higher extraction coefficients for secondary amines in less comprehensive tracer level studies.